

Application No. 09/547,790
Amdt Date June 5, 2003
Reply to Final Action of March 14, 2003

REMARKS/ARGUMENTS

Summary of Interview

During the interview claims 6, 12 and 33 were discussed in light of the following references:

- U.S. Patent 5,999,311 to Nanba et al.;
- U.S. Patent 4,531,197 to Lin;
- U.S. Patent 4,395,123 to Minott; and
- U.S. Patent 4,213,706 to Hill et al.

Applicants asserted that the "air gap" of claim 33 distinguished this claim from the cited prior art and that the "asymmetric pupil" of claim 12 was also distinctive. Applicants and the Examiner discussed amending the language of these claims to be more structurally descriptive. No agreement was reached between Applicants and the Examiner concerning any of the claims.

Overview of Amendments

The proposed amendments are discussed below in light of the objections and rejections made in the Office action dated March 14, 2003.

Claims 6-11

Claims 6-11 were rejected under 35 U.S.C. §103(a) as being obvious in light of U.S. Patent 5,999,311 to Nanba et al. (the Nanba et al. patent) and U.S. Patent 4,395,123 to Minott (the Minott patent). Applicants submit that the prior art cited by the examiner does not teach the limitations in claim 6 as amended of:

an entrance slit structure having an entrance slit extending in a first direction for receiving a beam of light having a photon flux within a predetermined spectral pass band;

a beam shearing system including:

a beam splitter on the surface of a prism that is aligned at an angle to the first direction so that the received beam of light is split into two separate beams;

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an air gap adjacent the surface of the prism on which the beam splitter is located;

a reflective subsystem having a plurality of reflective surfaces defining separate light paths of equal optical path length for the two separate beams, the reflective surfaces arranged such that when the two beams emerge from the beam shearing system they contain more than 50 percent of the photon flux and the chief rays of the two separate beams are substantially parallel to each other;

wherein the angle at which the beam splitter is aligned is less than the critical angle above which total internal reflection of a portion of the beam of light occurs; and

an optical system configured to recombine the two separate beams of light emerging from the beam shearing system onto an exit pupil.

Applicants submit that claims 7-11 depend from claim 6, therefore, these claims are also allowable as claims dependent upon an allowable base claim.

Claim 12

Claim 12 was rejected under 35 U.S.C. §103(a) as being obvious in light of the Nanba et al. patent, the Minott patent, U.S. Patent 4,213,706 to Hill (the Hill patent) and U.S. Patent 4,531,197 to Lin (the Lin patent). The Office action states that:

Nanba, Minott and Hill disclose the static interferometer recited above. However, the reference fail to specifically teach a fore-optics having an asymmetric pupil and configured to collect and focuses light into a beam.

Lin discloses a fore-optics of a shifted pupil design that collects and focuses light into a beam for entry into the spectral resolving system and a detector located at the exit pupil to receive and process image data.

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In response to Examiner's suggestion that the term shifted pupil is unclear, Applicants have amended claim 12 to refer to:

...
fore-optics having a pupil that is asymmetric relative to the chief ray and configured to collect light and focus it into a beam;
...

Applicants submit that the prior art cited by the examiner does not teach the limitations of claim 12. The Lin reference cited by the Examiner does disclose optics with the ability to shift the location of the pupil along the chief ray. However, the disclosed optics do not teach a pupil that is asymmetric relative to the chief ray.

In addition, the Office action contains the following statement:

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have included a fore-optics and detector as suggested above since one would be motivated to by freedom from an environment of perturbations (col. 1, lines 62 - 64), which increase accuracy of Fast Fourier Transforms data processing. Furthermore, according to Lin, in performing real-time Fourier Transforms, one skilled in the art would also recognize the ability to create compact and low-power transformers that ultimately decrease manufacturing and utilization costs (col. 1, lines 60 - 61).

Applicants submit that the above motivations would not in any way motivate one of ordinary skill in the art to combine the cited references in order to obtain the combination of claim 12. None of the limitations of claim 12 require "Fast Fourier Transforms data processing." Therefore, it is unclear how any of the above motivations would cause one of ordinary skill in the art to combine teachings from the cited prior art references.

Claims 13-22 and 31

Claims 13-22 and 31 were objected to as being dependent upon a rejected base claim. Therefore, claim 13 has been rewritten in independent form and claims 14-22 and 31 have been amended where

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necessary to depend from claim 13. Applicants submit these amendments overcome the above objections and that claims 13-22 and 31 are in condition for allowance.

Claims 30, 32 and 36-39

Claim 30 has been amended to depend from claim 23 and claims 36-39 depend from claim 23. The Office action dated March 14, 2003 states that claim 23 is allowable. Therefore, applicants respectfully submit that claims 30, claim 32 (which depends from claim 30) and 36-39 are allowable as they depend from claim 23.

Claim 33

Claim 33 was rejected under 35 U.S.C. 103(a) as being unpatentable over the Minott patent, the Hill patent and U.S. Patent 4,773,732 to Schaffer. The Office action states that:

Minott and Hill disclose the beam shearing system as recited above, however, the references fail to specifically disclose a first prism that serves as the beam splitter and second prism positioned to create an air gap between both prisms so as to prevent total internal reflection.

Schaffer discloses an interferometric beam shearing system that splits the incident beam with dual prisms (col. 1, lines 16 - 26) having an air gap.

Applicant's submit that use of an air gap interferometric beam shearing systems can result in problems due to total internal reflection. A surface of the first prism is designed to act as a beam splitter. However, if the beam strikes this surface at a critical angle that is dictated by the material from which the first prism is constructed and the frequency of light within the beam, then frequencies within the beam of light can be totally internally reflected, with the result that the beam is not sheared. The Schagger reference addresses this problem at Col 5, Lines 31 - 36:

The gap of about 1/10 mm which is technically unavoidable between the surrounding quartz glass structure T and the electro-optical crystal EOK is filled with an immersion liquid whose refractive index lies between that of the quartz glass and that of the KDP crystal to avoid reflection losses.

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The use of a filler material in an air gap to try and match refractive indexes and eliminate the risk of total internal reflection is a common solution to the problem of total internal reflection. A problem that can be encountered using this approach is that the filler materials typically absorb portions of the spectrum and, therefore, can be unsuitable for spectroscopy applications that do not involve monochromatic light. Applicants' invention has overcome this problem by constructing a beam shearing system having:

...

a first prism possessing a surface acting as a beam splitter;

a second prism positioned to create an air gap between the second prism and the surface;

wherein the first and second prisms are positioned such that the incident beam of light is incident on the surface at an angle that substantially prevents total internal reflection . . .

Applicants submit that the cited combination of references do not teach the limitations of the invention of claim 33, indeed, the references cited teach away from these limitations. Instead of positioning the first and second prisms such that the "incident beam of light is incident on the surface at an angle that substantially prevents total internal reflection," the references teach avoiding total internal reflection by filling the air gap with a material having a suitable refractive index.

In addition, the Office action states that:

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used dual prisms to split a beam since one would be motivated to prevent total internal reflection (col.1, lines 16-26). Ultimately, this is important precision control where light is at relatively high intensities (col. 2, lines 8 - 16).

The above statement does not address the specific combination of teachings relied upon in rejecting claim 33 and why one of ordinary skill in the art would be motivated to combine these

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teachings in the manner indicated in the Office action. The statement that one of ordinary skill in the art would "have used dual prisms to split a beam since one would be motivated to prevent total internal reflection" is respectfully submitted to be inappropriate. The use of dual prisms with an air gap creates the potential for total internal reflection. Therefore, Applicants submit that one, who is attempting to prevent total internal reflection, would not be specifically motivated to use a prism system involving air gaps. To the contrary, the prior art cited in the Office action teaches eliminating air gaps by filling them with materials. Therefore, Applicants respectfully submit that one of ordinary skill in the art would not be motivated to combine teachings from the cited prior art references.

Claims 34 and 35

Claims 34 and 35 were objected to as being dependent upon a rejected base claim. Therefore, both claims 34 and 35 have been rewritten in independent form. Applicants submit these amendments place claims 34 and 35 in condition for allowance.

Comments concerning reasons for allowance

Claims 23-29

The reasons for allowance of claims 23-29 are as follows:

As the claims were read and interpreted in light of the specification, the prior art of record fails to specifically disclose fore-optics of a shifted pupil design that collects and focuses light into a beam for entry into the spectral resolving system and a detector located at the exit pupil to receive and process image data. Furthermore, the references do not specifically disclose data processing using Fast Fourier Transforms on the digitized measurement to obtain spectral composition of the incident radiation and digital filters to detect the presence or absence of characteristically incident radiation by particular substances.

Applicants submit that independent claim 23, from which claims 24 - 29 depend, does not require any form of fore-optics, a detector or particular method of data processing. Applicant submits that claims 23-29 are allowable, because the prior art fails to disclose (see claim 23) :

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an entrance slit structure having an entrance slit extending in a first direction for receiving a beam of light having a photon flux within a predetermined spectral pass band;

a beam splitter aligned at an angle to the first direction so that the received beam of light is split into two separate beams;

a reflective subsystem having a plurality of reflective surfaces defining separate light paths of equal optical path length for the two separate beams, the reflective surfaces arranged such that one of the separate beams undergoes one reflection and the other of the separate beams undergoes three reflections and that when the two beams emerge from the beam shearing system they contain more than 50 percent of the said photon flux.

Claims 13-22 and 31

The statement of reasons for allowance provided in relation to claims 23-29 was also used in relation to the allowable subject matter covered by claims 13-22 and 31. Applicants submit that independent claim 13, from which claims 14-22 and 31 depend, does not require any form of fore-optics, a detector or particular method of data processing. Applicant submits that claims 13-22 and 31 are allowable, because the prior art fails to disclose (see claim 13) :

fore-optics having an asymmetric pupil and configured to collect light and focus it into a beam;

a spectral resolving system comprising:

an entrance slit structure having an entrance slit extending in a first direction for receiving a beam of light;

a beam shearing system including:

a beam splitter aligned at an angle to the first direction configured to split the received beam of light into two separate beams;

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a reflective subsystem having a plurality of reflective surfaces defining separate light paths of equal optical path length for the two separate beams, the reflective surfaces arranged such that when the two beams emerge the chief rays of the two separate beams are substantially parallel to each other; and

an optical system configured to recombine the two separate beams of light emerging from the beam shearing system onto an exit pupil; and

a detector located at the exit pupil.

Claim 34

The statement of reasons for allowance provided in relation to claims 23-29 was also used in relation to the allowable subject matter covered by claim 34. Applicants submit that independent claim 34 does not require any form of fore-optics, a detector or particular method of data processing. Applicant submits that claim 34 is allowable, because the prior art fails to disclose (see claim 34):

a first prism possessing a surface acting as a beam splitter;

a second prism positioned to create an air gap between the second prism and the surface;

wherein the first and second prisms are positioned such that the incident beam of light is incident on the surface at an angle that substantially prevents total internal reflection;

wherein the incident beam of light is split by the beam splitter into two separate beams of light that emerge from the beam shearing system; and

wherein the two beams of light are substantially parallel when they emerge from the beam shearing system and contain more than 50% of the incident light; and

wherein both the beams of light emerging from the beam shearing system include infrared radiation.

Claim 35

The statement of reasons for allowance provided in relation to claims 23-29 was also used in relation to the allowable subject matter covered by claim 35. Applicants submit that independent claim

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35 does not require any form of fore-optics, a detector or particular method of data processing. Applicant submits that claim 35 is allowable, because the prior art fails to disclose (see claim 35):

a first prism possessing a surface acting as a beam splitter;
a second prism positioned to create an air gap between the second prism and the surface;

wherein the first and second prisms are positioned such that the incident beam of light is incident on the surface at an angle that substantially prevents total internal reflection;

wherein the incident beam of light is split by the beam splitter into two separate beams of light that emerge from the beam shearing system; and

wherein the two beams of light are substantially parallel when they emerge from the beam shearing system and contain more than 50% of the incident light; and

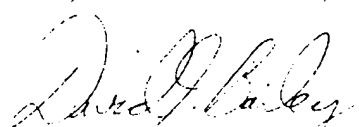
wherein both the beams of light emerging from the beam shearing system include ultraviolet radiation.

Conclusion

Applicant respectfully suggests that the proposed amendments will place all claims in condition for allowance and requests that the "Comments Concerning Reasons for Allowance" be amended as set forth above. In addition, Applicant wishes to thank the Examiner for extending the courtesy of attending the teleconference on Wednesday, May 21, 2003.

Respectfully submitted,
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Limited Recognition Under 37 CFR § 10.9(b)
626/795-9900

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